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SAMOS

A. SUMMARY

The purpose of this paper is to examine the requirements for a satellite photographic reconnaissance system, to examine our present proposed SAMOS photo satellite system and to propose a new system which we believe will more closely meet our requirements and will provide more growth potential. During the next few years it is going to be highly desirable that the United States be able to conduct photographic reconnaissance from satellites. The need for information collected in this fashion will be determined both by the current knowledge of the area to be observed and by the technical capabilities of the observation equipment.

1. Technical Capabilities of Equipment Planned for the SAMOS Program

The present SAMOS photographic program involves three payloads. The E-1 has a 6" focal length camera which will give the possibility of recognizing objects 250' on side. It takes a picture 100 miles square. This picture is transmitted to the ground by a facsimile system. The E-2 package has a 36' focal length and takes a picture 17 miles square in which a 50' object can be recognized. This information is also transmitted electronically to the ground. The E-5 package takes a picture 60 miles in width in which a 12' object can be recognized. This material is brought back by a recovery technique from the satellite. With perfect weather it would take one E-2 satellite 50c eighty days to cover the Soviet Union. With a multiplicity of satellites operating simultaneously this time can be cut down. If the system is not desired as a means of covering the entire Eurasian land mass, but is planned instead to be used to look at specific targets, a shorter time is needed. One E-2 satellite will require, in general, twelve days to get a picture of Moscow; seven days to get a picture of Novosibirsk. The E-5 system will cover the entire Eurasian land mass in about twenty days if there are no clouds.

2. Requirements

From consideration of technical capabilities of these payloads, it is apparent that the E-2 system cannot be asked to provide photographic information about any particular spot in the Soviet Union oftener than once every few days. However, it is doubtful that even this frequency will be required for viewing objects larger than 50' on side. The E-2 system is also incapable of giving complete coverage at any frequency greater than once every few months unless a multiplicity of satellites are used. The E-1 system can give complete coverage with greater frequency but at a much lower resolution. The E-5 system can also give complete coverage at a greater frequency. We believe there is a need for complete coverage at a resolution equivalent to the E-2, at a frequency perhaps once every 6 months. The E-5 system, on the other hand, produces more material than is probably needed for basic coverage.

3. New System Requirements and a Proposal

We believe that there is no intelligence need satisfied by the E-2 which cannot be better satisfied by a much simpler recovery system. We propose that the ultimate operational system consist of recovery packages only:

(1) To be a new system with a panoramic camera to give photographs of a 180 mile-wide swath with a recognizability of 50' objects. A single satellite would give complete coverage in a few days. Such a satellite might be put into orbit once every four to six months.

(2) The higher resolution E-5 with which photographs might be obtained over specific areas ~~once-a-year.~~ when needed,

We propose that the processing of such photographs be carried on through the same organizational system by which photographs are processed today. Such an operational plan would be very much less expensive than the one currently proposed and will provide a take of much higher intelligence value than the current plan. It will be flexible so that new ideas for payloads can be easily incorporated into the system. The current E-2 operational plan is completely inflexible.

B. DISCUSSION

1. There are two basic problems which we are confronted with today:

(1) What kind of satellite photographic reconnaissance system should the United States have?

(2) What kind of organizational system should handle the processing of results?

At the present time the Lockheed Aircraft Corporation is trying to develop a satellite system which will be capable of operating twelve simultaneous photographic reconnaissance satellites. These are to carry the E-2 payload. Such a system requires a great deal of ground equipment for a successful operation. Because of the format of the pictures and because of the programming complications of the satellites, a very complicated data handling technique has to be used. For one year's operation of the system the cost estimates run to [redacted] A very much simpler system can do all the things which E-2 can do. The main reason that E-2 has grown in this fashion seems to be that some years ago it was not felt possible to bring payloads back from orbit. This is now a technique which can be carried out without question and which is a firm requirement at the present time in the United States. An E-2 system involving few satellites and few read-out stations provides no competition for a single recovery satellite. A complete E-2 system of many satellites provides competition only if one neglects cost, complexity and flexibility.

2. E-2 System

There are two different problems to which the E-2 is dedicated;

(1) The problem of covering the entire Eurasian land mass.

(2) The problem of seeing a particular target.

A general calculation of the coverage provided by a read-out system involves the number of ground stations; the bandwidth of the read-out system; the weather, and resolution. The problem of viewing a particular spot requires consideration also of the width of the swath which can be covered on one orbital pass. Consider first the E-2 with its 17 mile-wide picture in a 300 mile orbit. To give the extreme case, let us make several false assumptions: 1) the weather is perfect; 2) the northern part of Russia is covered with sunlight in the winter; 3) the E-2 satellite can be tilted so that the ground aiming point can be placed anywhere between successive ground tracks. (This last assumption is important because of "resonances", i.e. as the earth rotates, the satellite ground tracks might repeat); 4) Everyghing the satellite records can be read-out over the United States thru the data link.

At 33° North Latitude with a polar orbit the distance between successive ground tracks is 1350 statute miles. A single E-2 payload with its 17 mile wide picture would thus take $\frac{1350}{17}$, or eighty days for complete coverage. If new additional satellites were added, the coverage time could be cut down. Ten simultaneous satellites would reduce the coverage time to eight days.

Let's consider next the readout limitation for the E-2 package. Two tracking and acquisition stations can handle approximately 1860 linear miles/day. This extends the time for coverage by a single bird to approximately 500 days.

The weather problem is worse because of the fact that weather tends to correlate from day to day. Because of this, even with 12 satellites, we can probably never get 100% coverage. If one assumes that 50% of the USSR is always covered by clouds, then in 250 days the E-2 bird with 2 T&A stations would cover 50% of the land mass. In this case the bandwidth limitation is divided by two because it is assumed the satellite could be turned off sometimes if bad weather arises.

In practice, a single E-2 package could also probably never cover the Soviet Union because it cannot be tilted to fill the gap between different ground tracks. Even if such tilting were technically feasible, it would be undesirable because of the extreme obliquity of the resulting photographs. The angle to the horizontal at the extreme would be 21° and the recognizability would become 137'. The arctic night would also impose some restrictions on the time at which complete coverage could be obtained.

Consider next the problem of looking at a particular target. With the E-2 package, if we make the same assumption as in the coverage case, the target can be seen once a day by one E-2 payload. In this case the effect of weather is profound. The following section shows the weather problem for particular targets.

Mean Number of Satellite Days for coverage probability of 0.95 for fixed (17 mile wide) and trainable (75, 100, 200 & 300 mile wide swath) cameras for specific locations, for a winter month (Jan) and a summer month (July) for orbital inclinations of 83° & 70° (without illumination degradation effects) and given 15½ rev/day

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Photo Width	Orbit	Month	Moscow	Sverdlovsk	[redacted]	Irkutsk	Novosibirsk	Astrakhan	Peking
17	70°	Jan	175	125	[redacted]	80	115	195	70
		July	125	95	[redacted]	130	105	90	140
	83°	Jan	210	140	[redacted]	105	125	235	95
		July	140	115	[redacted]	125	115	95	165
75	70	Jan	40	28	[redacted]	18	26	44	16
		July	28	22	[redacted]	30	24	20	36
	83	Jan	48	32	[redacted]	24	28	54	22
		July	32	26	[redacted]	28	26	22	38
100	70	Jan	30	21	[redacted]	14	19	33	12
		July	21	16	[redacted]	22	18	15	27
	83	Jan	36	24	[redacted]	18	21	40	16
		July	24	20	[redacted]	21	19	16	28
200	70	Jan	15	10	[redacted]	7	10	16	6
		July	10	8	[redacted]	11	9	8	14
	83	Jan	18	12	[redacted]	9	10	20	8
		July	12	10	[redacted]	10	10	8	14
300	70	Jan	10	7	[redacted]	4.5	6.5	11	4
		July	7	5.5	[redacted]	7.5	6	5	9
	83	Jan	12	8	[redacted]	6	7	13.5	5.5
		July	8	6.5	[redacted]	7	6.5	5.5	9.5

3. E-1 System

Because of its low resolution the E_1 system will only recognize objects which are more than 250' on a side. Accordingly, it cannot be reasonably considered for a point target surveillance mission. Certainly, areas 250' on a side are going to change character very slowly. In its present form the E-1 is being flown primarily as a component development package.

The E-1 takes a 100 mile-wide picture and can thus give coverage much more quickly than E-2. With the assumption of perfect weather, and sunlight in Northern Russia, the coverage would be complete in twenty days. With weather consideration it would take 200 days to get 95% of Russia covered. There is no readout limitation here as in E-2.

C. PROPOSALS

It has been proposed that the failure of the E-2 system to provide coverage be rectified by adding E-1 packages. We would like to propose instead that a new camera be substituted for E-1, because of its low resolution. We also propose that the new camera have a wider swath and thus provide coverage in a shorter time than E-1. This new system will have five times the resolution, speedier coverage and less cost. We believe that this new system will come much closer also to meeting a national requirement than the current E-2 plan.

This system should be a recovery system in order to get rid of the bandwidth limitation mentioned above. With a 150 mile-wide swath from a panoramic camera and with perfect weather complete coverage could be obtained with one bird in about ten days. With weather ~~80%~~ 50% would be covered in 10 days and possibly 75% in 20 days. This should be an ATLAS boosted program so as to carry the film load required for such coverage. The system should have 50' recognizability which is the same as the E-2.

We would like to propose that the current E-2 program be completely divorced from any intelligence implications and that it be continued only for the purpose of learning about the problem of developing this type of facsimilie equipment.

We propose that the E-2 program cease after four shots.

In place of the remaining four currently programmed E-2 flights, we propose a series of firings involving an ATLAS boosted "AGENA" with a recoverable panoramic camera capable of giving 50' recognizability. The impact of such a system should be profound on "Pice", Subsystem I, Ground Data Reconstruction Equipment, T&A Stations and Data Links, and should be considerably less expensive than the cost of the previous system.

D. PROCESSING

It is currently planned to process satellite reconnaissance photography at the Strategic Air Command and to control the entire collection system by SAC. It is necessary to examine SAC's intelligence needs to see if it is proper for any of these functions to be located at SAC Headquarters or even under control of SAC.

SAC has two intelligence problems; (1) a pre-strike problem, and (2) a post-strike problem. In the pre-strike situation, the US exists as it does today. Intelligence facilities in the United States are much greater than any which could be pulled together by SAC at its Headquarters. There are brighter analysts in the rest of the United States and more analysts in the rest of the United States than there are at SAC. SAC certainly has no need of any raw data. It has requirements for information about the Soviet Union, which it needs for planning its operations. It needs targeting data. It needs data on Soviet intercept capabilities and its air defense. I feel the United States is capable of doing a superb job of providing SAC with this information. I believe SAC should be able to get all it needs from the United States and should have the best. I think it is important for the community to be told how best it can solve the problems of SAC. In the pre-strike environment, telephone and telegraph lines are all operating and the problem of communicating with SAC is easy.

In a post-strike situation, SAC is at war. The United States is devastated. SAC certainly needs intelligence and in this environment SAC will need its own capabilities. I feel we need to know what is the post-strike requirement for SAC intelligence. Since SAC is a prime target there should probably be a minimum of equipment at SAC for the post-strike problem. The intelligence system in this environment should probably be extremely simple because of the confusion which is likely to reign. As presently conceived, SAMOS is primarily a pre-strike device and should probably be assigned to some joint intelligence center. This center should be an expansion of one of the existing photo-intelligence centers. Its output should go to all consumers of intelligence information.